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Original Research Article

Assessment of Fluoride in Ground Water for Drinking and Agricultural Purposes in Ramannapet Mandal of Nalgonda District, Telangana, India

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ABSTRACT

The fluoride concentration in ground water was analyzed during *kharif* and *rabi* (2012-13) seasons to identify the suitability of water for drinking and irrigation purposes in all the villages of Ramannapet Mandal of Nalgonda District, Telangana. Fluoride present in the ground water samples collected during *kharif* and *rabi* varied from 0.53 to 3.86 and 0.99 to 3.94, with an average of 1.71 and 2.08 ppm, respectively. As per drinking water standards, 53 % (16 samples) of the ground water samples in kharif and 67% (20 samples) of the ground water samples in rabi have fluoride content greater than that of maximum permissible limit of 1.50 ppm fluoride. On an average, maximum concentration of fluoride was noticed in 16 and 20 villages during *kharif* and *rabi*, respectively. Therefore drinking water is sufficient to produce severe form of dental fluorosis and mild form of skeletal fluorosis consumed for a long period. As far as irrigation is concerned, data show that none of the bore well and open well water samples have fluoride content above 10 mg L^{-1}, which is the safe limit for all type of crop plants. Thus, all water samples tested in this investigation can safely be used for agricultural purpose.

Keyword: Fluoride; Ground Water; Drinking; Irrigation; Nalgonda

INTRODUCTION

The occurrence of the high fluoride concentrations in ground water is a problem faced by many countries; India is one among the 23 nations in the world. Over all 200 million people in worldwide and 65 million people among 29 states of India are facing the problem

with fluorosis as groundwater of Indian aquifers varies from < 1.0 to 25.0 ppm. The probability of occurrence of high fluoride concentration in ground and surface water was detected in various states in India. Telangana state is facing major problem with fluoride pollution because ground water is used as drinking and an irrigation source, a natural occurrence of excessive amounts of fluoride levels in ground water. Nalgonda district is one of the poorest and most drought-prone districts of Telangana in southern India. The area has long been associated with high groundwater fluoride concentrations which have been reported to reach up to 20 ppm [1]. In spite of continuous efforts by the government, external support agencies, NGOs and private enterprises the problem still remains unsolved.

The main natural sources of fluoride in the ground water of Nalgonda district are weathering and dissolution of rocks and minerals, emissions from volcanoes and marine aerosols [2]. This high concentration of fluoride in drinking water causes dental and skeletal fluorosis in human beings and also has negative effect on crop production. So periodical measurement and control of the concentration of fluoride is very important to avoid both biological and environmental damage. Hence, keeping in view the above facts a survey was conducted to identify the suitability of ground water for drinking and irrigation purposes.

MATERIALS AND METHODS

The study area forms a part of Nalgonda district, Telangana, which is located at a distance of 90 km away from Hyderabad (Fig. 1). This area experiences arid to semiarid climate. The study area goes through hot climate during the summer (March–May) with a temperature range from 30◦C to 46.5◦C, and in winter (November–January), it varies between 14◦C and 29◦C. The average annual rainfall in this area is about 1000 mm, occurring mostly during south-west monsoon (June–September).

Groundwater samples were collected during the *kharif* (September) and *rabi* (March) seasons of 2012-13from existing water sources (open wells and bore wells) with the help of a handheld Global Positioning System (GPS).Geographical information *viz*., latitude and longitude of the benchmark sites were recorded, so that the delineation of the areas having fluoride pollution can be done and ground water fluoride status maps can be prepared by depicting the element in water at village level. Totally 30 benchmark sites were fixed depending on the number of villages of study area for collection of water samples. The depth of the wells varied from 16to about 30 m below ground level.

Water samples were collected in clean polyethylene bottles of 600 ml capacity. The sampling bottles were soaked in 1:1 diluted HCl solution for 24 h and washed with distilled water. In the case of bore wells, water samples were collected after pumping the water for 10 min. In the case of open wells, water samples were collected 30 cm below the water level using a depth sampler. Samples collected were transported to the laboratory and filtered using 0.45µm Millipore filter paper fortified with 1 ml toluene to arrest any biological activity. The samples were stored at 4^0C until used for fluoride analysis. Fluoride was analyzed by using Specific Ion Electrode method [3].

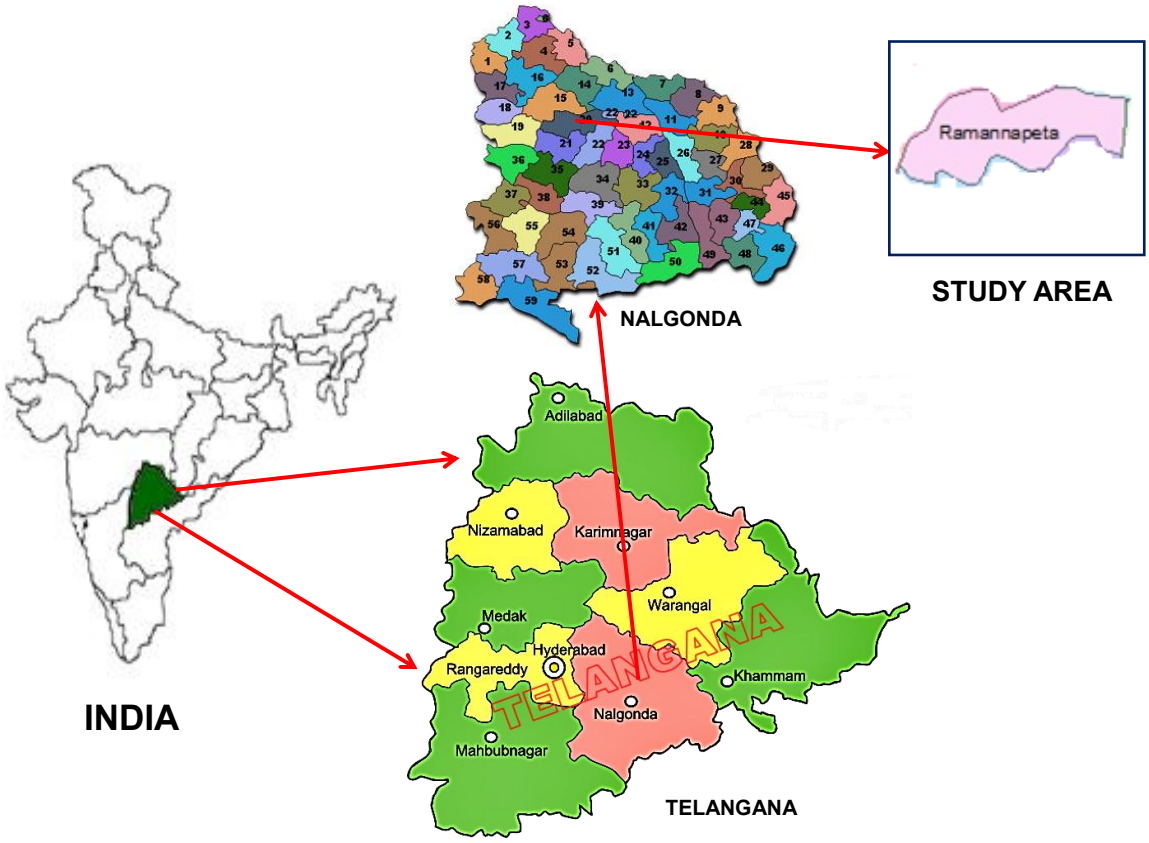

Fig. 1: Location map of the study area

RESULTS AND DISCUSSION

Fluoride content of ground water collected from open and bore wells in the villages of Ramannapet mandals of Nalgonda district during *kharif* and *rabi* are presented in Table 1. Fluoride present in the ground water samples collected during *kharif* and *rabi* varied from 0.53 to 3.86 and 0.99 to 3.94, with an average of 1.71 and 2.08ppm F, respectively. Lowest content of fluoride was recorded in Venkatapuram village (0.53 and 0.99 ppm during *kharif* and *rabi*, respectively) while the highest was recorded in Rontakolla village (3.86 and 3.94 ppm during *kharif* and *rabi*, respectively). Groundwater F status map during *kharif* and *rabi* are shown in figures 2 and 3.

Table 1: Fluoride content in ground water samples collected in different villages of Ramannapet mandal during *kharif* (September) and *rabi* (March) seasons of 2012-13.

S.No.	Village	Fluoride Content (ppm)	
		kharif	*rabi*
1	Ramannapet	1.46	1.51
2	Neernemula	0.78	1.17
3	Shobanadripuram	0.95	1.05
4	Laxmapuram	1.72	2.25
5	Nidhanpalle	0.98	1.21
6	Bogaram	1.03	1.27
7	Thummalagudem	1.15	2.53
8	Yellanki	2.28	2.75
9	Siripuram	2.07	2.12
10	Dubbaka	2.52	2.56
11	Rontakolla	3.86	3.94
12	Munipampula	2.35	2.33
13	Palliwada	0.92	2.58
14	Nagulanchagudem	1.29	3.12
15	Bachuppala	1.37	1.43
16	Suraram	2.43	2.48
17	Thurkapalle	2.76	2.73
18	Venkatapuram	0.53	0.99
19	Kunkudupamula	1.27	1.36
20	Peddabavigudem	2.09	2.52
21	Yennaram	1.98	1.99
22	Kallonikunta	2.04	2.15
23	Kakkireni	0.94	1.29
24	Pilligudem	2.82	2.84
25	Uttatoor	1.54	1.67
26	Iskilla	0.97	1.23
27	Lacchigudem	2.08	2.58
28	Janampalle	2.04	3.12
29	Sanjeevaiahnagar	0.85	1.39
30	Kommaigudem	2.23	2.36
	Range	**0.53-3.86**	**0.99-3.94**
	Mean	**1.71**	**2.08**

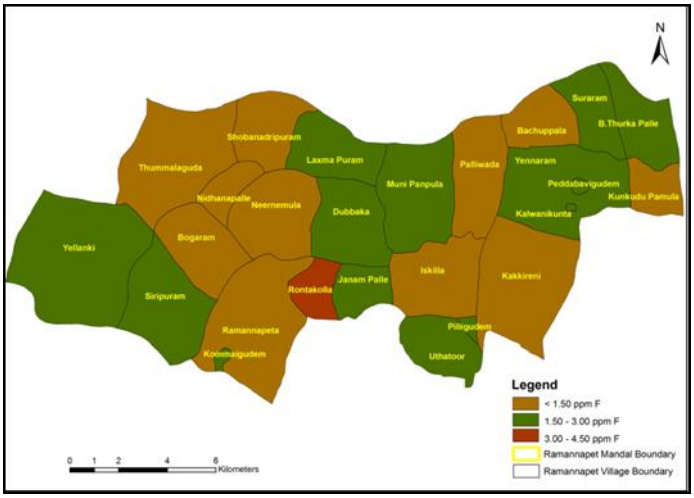

Fig.2: Ground water fluoride status map of Ramannapet mandal (Kharif, 2012)

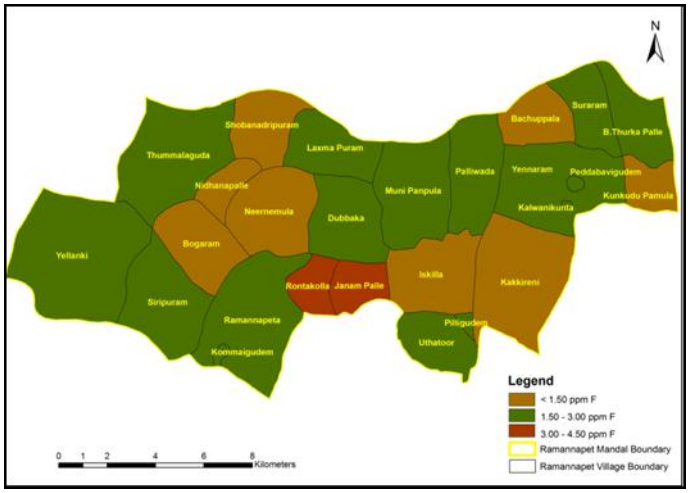

Fig.3: Ground water fluoride status map of Ramannapet mandal (Rabi, 2012-13)

As per drinking water standards of ICMR [4], the highest desirable concentration of F is 1.0 ppm in tropical countries and that of maximum permissible level is 1.50 ppm. Out of 30 samples, 53% of the ground water samples in kharif and 67% of the ground water samples in rabi have F content greater than that of maximum permissible limit of 1.50 ppm fluoride. On an average, maximum concentration of fluoride was noticed in 16 and 20 villages during *kharif* and *rabi*, respectively. Therefore drinking water is sufficient to produce severe form of dental fluorosis and mild form of skeletal fluorosis consumed for a long period. The rocks of this area possess fluoride content higher than the world average. Weathering of rocks and leaching of fluoride bearing minerals from the basement granitic rocks are the major reasons which contribute to elevated concentration of fluoride in ground water. The other important natural phenomenon that contributes to high fluoride is evaporation [5]. Similar results reported by Reddy *et al*. [6] and Kishore and Hanumantharao [7] in Nalgonda district.

According to FAO [8], the normal and moderately suitable range of fluorides concentration in irrigation water is from < 19 ppm (1.0 me L^{-1}) and 19 to 171 ppm (1.0-15 me L^{-1}), respectively. Safe limit of 10 mg F $L^{-1}$of

irrigation water has been proposed for all type of crop plants by Leone *et al*. [9]. The present investigation showed that none of the water samples were found to cross this limits and hence suitable for irrigation purpose. However continuous application of irrigation waters having toxic concentration of fluoride is likely to affect adversely the crop growth.

Especially higher F concentrations were observed in bore well water samples (>1.5ppm) and the F concentration in dug well water samples found to be within permissible limit of 1.5 ppm. The concentration in general, increases with the depth of bore wells and this indicates the possible geogenic nature of fluoride.

SEASONAL VARIATIONS OF FLUORIDE

When compared to two seasons, the concentration of fluoride in groundwater during *kharif* was lower than the *rabi*. Seasonal distribution is found significantly and the variation of fluoride is dependent on many factors. Generally, a high rate of evapo-transpiration and over-exploitation of groundwater resources for agricultural and drinking water purposes during *rabi* season causes a low freshwater exchange and results in precipitation of salts, including F rich salts, temporarily in the top layers of the soil. During *kharif* season, the infiltrating waters leach these soils and replenishment of the groundwater by rainfall indicated a clean recharge from external sources. Hence, the concentration of fluoride is observed to be greater in the *rabi* season groundwater than in *kharif* season. As a result, 67% (20 samples)of the total groundwater samples from the *rabi* season are above the permissible limit of fluoride (1.50 ppm), compared to 53% (16 samples) of those from the *kharif* season.

Seasonal distribution of fluoride is also dependent on amount of soluble and insoluble fluoride in source rocks, the duration of contact of water with rocks and soil temperature, rainfall and oxidation- reduction process [10 & 11].

CONCLUSION

High concentration of fluoride in groundwater of up to 3.94 ppm was measured. About 60% of wells had fluoride concentration above the permissible limit of 1.5 ppm set by Indian drinking water standard. The use of groundwater for drinking purpose from these wells has to be restricted. Suitable measures such as defluorinating the ground water before use and recharging the ground water by rainwater harvesting for irrigation purpose need to be practiced to improve the groundwater quality in this area.

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CONFLICT OF INTEREST STATEMENT

The authors declare that they have no competing interests.

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